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For: CONTROL APPARATUS FOR A BOOM IRRIGATOR, AND A METHOD AND SYSTEM RELATING THERETO

TRANSMITTAL LETTER

Assistant Commissioner for Patents
Washington, D.C. 20231

Enclosed for filing in the above-referenced application are the following:

☒ Certified copy of Priority Document No. PR 3395, filed on February 27, 2001

☒ Any deficiency or overpayment should be charged or credited to deposit account number 13-1703. A duplicate copy of this sheet is enclosed.

Respectfully submitted,

MARGER, JOHNSON &
McCOLLOM, P.C.

Alan T. McCollom
Registration No. 28,881

MARGER, JOHNSON &
McCOLLOM, PC
1030 SW Morrison Street
Portland, OR 97205
(503) 222-3613

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ORIGINAL

AUSTRALIA

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PROVISIONAL SPECIFICATION

Invention Title: "Control Apparatus for a Boom Irrigator, and a Method and System Relating Thereto"

The invention is described in the f llowing statement:

"Control Apparatus For A Boom Irrigator, And A Method And System Relating Thereto"

Field of the Invention

This invention relates to the field of boom irrigators, and in particular to a control apparatus for a boom irrigator, a system for controlling a boom irrigator, and a method for controlling a boom irrigator. The invention is applicable to both linear boom irrigators and to centre-pivot boom irrigators.

Background Art

Boom irrigators are used to water large areas of land. A boom irrigator is formed in sections, with each section having multiple nozzles to release water. Each section is supported on wheels and includes a motor for driving that section. Adjacent sections are articulated. A switch at the articulation joint determines when the adjacent sections are no longer parallel by more than a predetermined angle, which activates the motor on one of the sections to bring the sections back into line. In this manner, one section can be set to move at a fixed pace and the remaining sections will automatically move to remain in line. Boom irrigators having a length of 500 metres are not uncommon, and lengths of up to 800 metres have been used. Each section in a boom irrigator is typically 50 to 70 metres in length.

There are two main types of boom irrigators, namely linear and centre pivot. Linear boom irrigators move the entire boom irrigator over an area as a line. In order to supply water to the moving boom irrigator, either a hose connected to a water source needs to be provided to unreel as the boom irrigator moves, or alternatively a channel needs to be provided parallel to the boom irrigator at one end for the boom irrigator to draw water from.

Centre pivot boom irrigators make use of a fixed water source at one end of the boom irrigator, with the boom irrigator traversing a circle about the water source.

Centre pivot boom irrigators are popular because of the ease with which water can be supplied to the boom irrigator from a fixed point. One problem with centre pivot boom irrigators is that if each section in the boom irrigator has the same number of nozzles and the nozzles are of the same type, the centre of the circle traversed by the boom irrigator receives more water than the areas near the circumference of the circle. A common way of addressing this problem is through the use of manual valves provided in each section of the boom irrigator that controls the flow of water to the nozzles in that section. A farmer can then adjust the manual valves to control the distribution of water along the length of the boom irrigator. Unfortunately, this method is cumbersome for use by the farmer and provides at best a coarse control over the water distribution. Since it is impractical for a farmer to adjust the valves on the boom irrigator as the boom irrigator is in motion, this method necessarily results in the same water distribution being applied equally around the circle.

Another solution to this problem involves providing electrically operated valves along the innermost sections of the boom irrigator and a programmable logic control (PLC) system on the boom irrigator. The PLC system switches each solenoid on and off at pre-programmed intervals in order to regulate the water supplied close to the centre pivot. The PLC systems tend to be restricted in their configurability due to inherent limitations in programming PLC systems. Further, a separate pair of wires is used to provide power to each solenoid, resulting in many wires being used along the boom irrigator. Since only the innermost sections of the boom irrigator are controlled, no control is provided over the remainder of the boom irrigator. The PLC system is arranged to regulate the water supply on the innermost sections at a predefined rate, and thus the same rate of water supply is provided along the circular path traversed by the boom irrigator.

Disclosure of the Invention

Throughout the specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood

to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

In accordance with a first aspect of this invention, there is provided a control apparatus for a boom irrigator, comprising:

processor means and associated memory storing data corresponding to a desired distribution of fluid;

a plurality of control circuits provided along said boom irrigator, each control circuit being in communication with the processor means, each control circuit arranged to actuate at least one fluid control device associated therewith in response to instructions received from said processor means;

said processor means responsive to said data in the associated memory and arranged to communicate with the plurality of control circuits to control operation thereof according to said data.

Preferably, said control apparatus further comprises a position determining device in communication with said processor means, said processor means being responsive to said position determining device in accessing said data.

Preferably, said control apparatus further comprises position data, said processor being responsive to said position data and said position determining device in accessing said data.

Preferably, said plurality of control circuits are in communication with said processor means via a common communications bus. In one arrangement, each control circuit has an unique identifier among said plurality of identifiers, said processor means including said identifier in communications to said control circuit.

Preferably, each control circuit includes an instruction buffer for receiving and storing instructions from said processor means, said control circuit responsive to said stored instructions in its buffer to actuate the associated fluid control devices.

Preferably, said fluid control devices are configured to fail in an open position.

Preferably, at least one of said fluid control devices is connected to a source of an additive fluid, said associated memory including further data corresponding to a desired distribution pattern for each additive fluid, said processor means responsive to said further data to communicate instructions to the control circuit associated with the fluid control devices connected to the source of an additive fluid to control operation thereof according to said further data.

In accordance with a second aspect of this invention, there is provided a system for controlling a boom irrigator, comprising:

a control apparatus comprising:

processor means and associated memory storing data corresponding to a desired distribution of fluid;

a plurality of control circuits provided along said boom irrigator, each control circuit being in communication with the processor means, each control circuit arranged to actuate at least one fluid control device associated therewith in response to instructions received from said processor means;

said processor means responsive to said data in the associated memory and arranged to communicate with the plurality of control circuits to control operation thereof according to said data;

a computer system executing software arranged to allow a user to input desired distribution data for said fluid and each said additive fluid and to

store said data, said computer system arranged to communicate said data to said associated memory of said control apparatus.

Preferably, said control apparatus further comprises a position determining device in communication with said processor means, said processor means responsive to said position determining device in accessing said data.

Preferably, said control apparatus further comprises position data, said processing being responsive to said position determining device in accessing said data.

Preferably, said associated memory includes a removable portion, said computer system including an interface arranged to receive said removable portion and to store said data thereon.

Preferably, said plurality of control circuits are in communication with said processor means via a common communications bus. In one arrangement, each control circuit has an unique identifier among said plurality of identifiers, said processor means including said identifier in communications to said control circuit.

Preferably, each control circuit includes an instruction buffer for receiving and storing instructions from said processor means, said control circuit responsive to said stored instructions in its buffer to actuate the associated fluid control devices.

Preferably, said fluid control devices are configured to fail in an open position.

Preferably, at least one of said fluid control devices is connected to a source of an additive fluid, said associated memory including further data corresponding to a desired distribution pattern for each additive fluid, said processor means responsive to said further data to communicate instructions to the control circuit associated with the fluid control devices connected to the source of an additive fluid to control operation thereof according to said further data.

In accordance with a third aspect of this invention, there is provided a method for controlling a boom irrigator, comprising:

storing data corresponding to a desired distribution of fluid over an area;

providing a plurality of control circuits along said boom irrigator;

instructing each control circuit to actuate at least one fluid control device associated therewith in accordance with said data.

Preferably, said method further comprises the step of determining a position of the boom, and using said position to access said data.

Preferably, said method further comprises the step of storing instructions in each control circuit, and using said stored instructions actuate the associated fluid control devices.

Preferably, said method further comprises the steps of:

connecting at least one of said fluid control devices to a source of an additive fluid;

storing further data corresponding to a desired distribution pattern for each additive fluid; and

instructing the control circuit associated with the fluid control devices connected to the source of an additive fluid to control operation thereof according to said further data.

Brief Description of the Drawings

This invention will now be described with reference to one embodiment thereof and the accompanying drawings, in which:

Figure 1 shows a software application for managing distribution of water and additives in accordance with the embodiment;

Figure 2 shows a configuration screen for creating a new centre pivot used in the software application shown in Figure 1;

Figure 3 shows the software application of Figure 1 with a pivot created;

Figure 4 shows the software application of Figure 1 with two data maps created;

Figure 5 shows a data map editing screen of the software application shown in Figure 1, which is shown editing the water distribution; and

Figure 6 shows a data map editing screen of the software application shown in Figure 1 in relation to editing the distribution of an additive.

Best Mode(s) for Carrying Out the Invention

The embodiment relates to a system for controlling a boom irrigator comprising a control apparatus and a computer system, and to a method relating thereto. The embodiment will be described with reference to centre pivot boom irrigators, however it should be appreciated that the invention is not limited to centre pivot boom irrigators.

In the embodiment, the controller comprises a microprocessor and associated memory, a global positioning system (GPS) device and an interface circuit. The GPS device is connected to the microprocessor which periodically receives position information from the GPS device. In the embodiment, the interface circuit is a serial RS-485 interface which is connected to the microprocessor. In other embodiments, alternative interface circuits may be used, for example optic fibre communications.

The controller also includes control circuits provided along sections of a boom irrigator. Typically, one control circuit will be provided in each section of the boom irrigator, however multiple control circuits can be provided in a single section if desired. Each control circuit is associated with a solenoid which controls the flow of water from nozzles in that section. All of the control circuits are connected to the RS-485 interface circuit via a single set of communication wires.

In the embodiment, the GPS device is located adjacent the end of the boom irrigator that is not fixed at the centre pivot. In other embodiments, multiple GPS devices may be used for increased accuracy. The positions of the sections of the boom irrigator are calculated from the known position of the centre pivot and the position information received from the GPS device.

The position of each section of the boom irrigator is used to access data stored in the associated memory to determine the desired watering distribution and additive quantity. Once the desired watering is known for each section and the desired additive quantity is known, the microprocessor issues instructions to each of the control circuits via the RS-485 interface. Each control circuit includes an identifier that is unique amongst the control circuits in use on the boom irrigator. The unique identifier of each control circuit is used by the microprocessor to issue instructions to a specific control circuit.

In the embodiment, the user can select water regulation as a percentage from 0-100 per cent. This is implemented in the embodiment by the microprocessor issuing instructions to each control circuit every ten seconds such that the solenoid associated with each control circuit has a duty cycle that corresponds with the percentage indicated by the user.

To allow a user to manage the data regarding the desired distribution of water and additives, a computer system is provided which executes computer software that allows a user to manage the data corresponding to the desired distribution of water and additives.

Figure 1 shows the main window 10 of the software, which includes an add pivot button 12, an add data map button 14, a query pivot button 16, a delete irrigation data map button 18 and a delete pivot button 20. A display section 22 is also provided in the main window 10.

To manage the distribution of water and additives from a centre-pivot irrigator, a user selects the add pivot button 12, in response to which the computer software displays a map set up screen 40, which is shown in Figure 2. Using the map set up screen, the user is able to enter a name for the centre-pivot irrigator at 42, which allows the user to differentiate between centre-pivot irrigators where multiple irrigators are managed using the software. The user is also able to indicate a communications port at 44 and telephone number at 46 which the computer uses to communicate with the controller on the centre-pivot boom irrigator via a modem and radio or satellite communications link when the query irrigator button 16 is pressed.

The latitude and longitude of the centre of the centre-pivot boom irrigator is entered at 48. Whilst this is not required for the software to manage the map, it provides necessary information for the controller in determining the position of the boom irrigator and accordingly which part of the data map to use in distributing the water and additives.

The user can also enter information regarding the pivot rotation of the boom irrigator at 50, including whether the irrigator traverses a full circle or only a partial circle, and in the event that a partial circle is traversed, the start and stop angles. The position of a GPS receiver on the boom irrigator from the centre of the pivot irrigator is also indicated at 50. The length along the boom irrigator that the GPS receiver is positioned is also used by the controller in determining the position of the boom irrigator in use.

The user is also able to enter information concerning the angular resolution of the map by indicating the number of degrees over which the user requires control at 52. The user also enters the number of independent control circuits operating along the boom irrigator at 54. The user can enter the relative length of each

zone controlled by a control circuit, including whether each control circuit controls an equal length along the boom irrigator, or whether each control circuit controls differing lengths along the boom irrigator at 56. Once the information has been entered by the user, an icon 60 is shown in the display area 22 to represent the new centre-pivot boom irrigator. The icon 60 has an associated name 62 which is user-editable, as shown in Figure 3.

To add a data map to a particular centre-pivot irrigator icon 60, the user selects the icon 60 that he wishes to add a data map to and selects the add data map button 14. Multiple data maps are allowed for a single pivot irrigator icon 60. An example of this is shown in Figure 4, in which two data map icons 64a and 64b associated with the centre-pivot irrigator icon 64. Each of the data map icons 64a and 64b has an associated name representing the information content of the data map. Thus, the user can conveniently create several different data maps corresponding to different types of water and additive distributions and can simply recall the desired data map for transfer to the controller.

To manage the distribution of water and other additives in a data map, the user simply selects the data map icon 64a or 64b of the data map he or she wishes to maintain. Upon doing so, the user is presented with the data map editor screen 70 which is shown in Figures 5 and 6. Figure 5 shows the data map editor screen 70 covering the distribution of water present in the data map, and Figure 6 shows the data map editor screen 70 showing the distribution of a first additive. In total, four additives can be administered using the data map editor. A user selects whether they wish to view and edit the water distribution or any of the four additive distributions using the selection button 72a-72e.

The data map editor screen 70 also includes selection buttons 74a-74c, which correspond with the actions of a user being applied to all segments in a one segment-wide annulus that includes the selected segment, a one segment wide radial arc including the selected segment, or the selected segment only, respectively. This provides the user with a degree of control and convenience in indicating the desired distribution. The data map editor screen 70

also includes percentage selection buttons shown at 76, which provide predefined percentage distributions and corresponding colour indications. The percentage distribution buttons 76 allow the user to select a desired percentage to be applied to a data map.

The data map editor screen 70 also includes a display portion 78 that includes a map 80 of the area traversed by the boom irrigator. The map 80 consists of a plurality of concentric circles 82, the number of which is determined by the number of independent control circuits indicated by the user at 54. The map 80 also includes a plurality of radial lines 84 which are spaced apart according to the number of degrees in each area of control indicated by the user at 52. The relative spacing between the concentric circles 82 is determined by the radial length controlled by each control circuit input by the user at 56.

In the embodiment, the map 80 is shown as a complete circle, however where a partial circle is indicated by the user at 50, then the map 80 will also reflect this. A user is able to indicate a desired distribution by using the control buttons 74a-74c and the percentage selection buttons 76 in order to fill arcs, annuluses and individual segments 86.

In the embodiment, only the control button 74 is available when a user is editing the distribution map of the additives corresponding to selection buttons 72b-72e. This is because in the embodiment, additives are controlled at the centre pivot and are fed into the water supply for the entire boom. Accordingly, any additive injected into the water supply will be distributed evenly throughout the length of the boom. Note that in other embodiments, circuit-specific control of each additive may be provided if required, however this introduces an additional degree of complexity in distributing the additives to each control circuit.

It should be readily apparent to a skilled addressee that the system and method of embodiment provides a convenient way for a person to control the distribution of water and several additives of a boom irrigator. The data maps administered using the computer software system can be transferred to the associated

memory of the microprocessor in the controller using any known interface, or even via a radio-wave communication system.

It should be appreciated that the scope of this invention is not limited to the particular embodiment described above. For instance, although the embodiment has been described with reference to centre-pivot boom irrigators, it should be readily apparent that the invention can be readily adapted to other forms of boom irrigators.

Dated this twenty-seventh day of February 2001.

Computronics Corporation Limited
Applicant

Wray & Associates
Perth, Western Australia
Patent Attorneys for the Applicant(s)

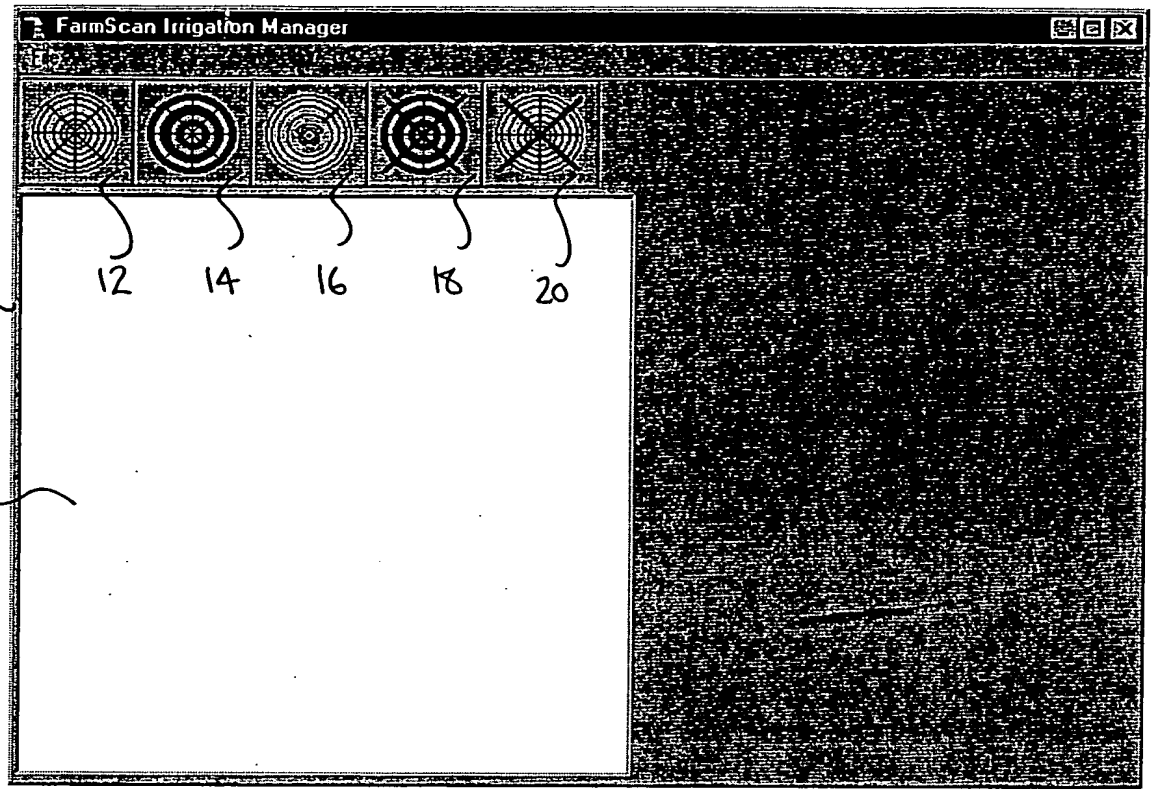

Figure 1

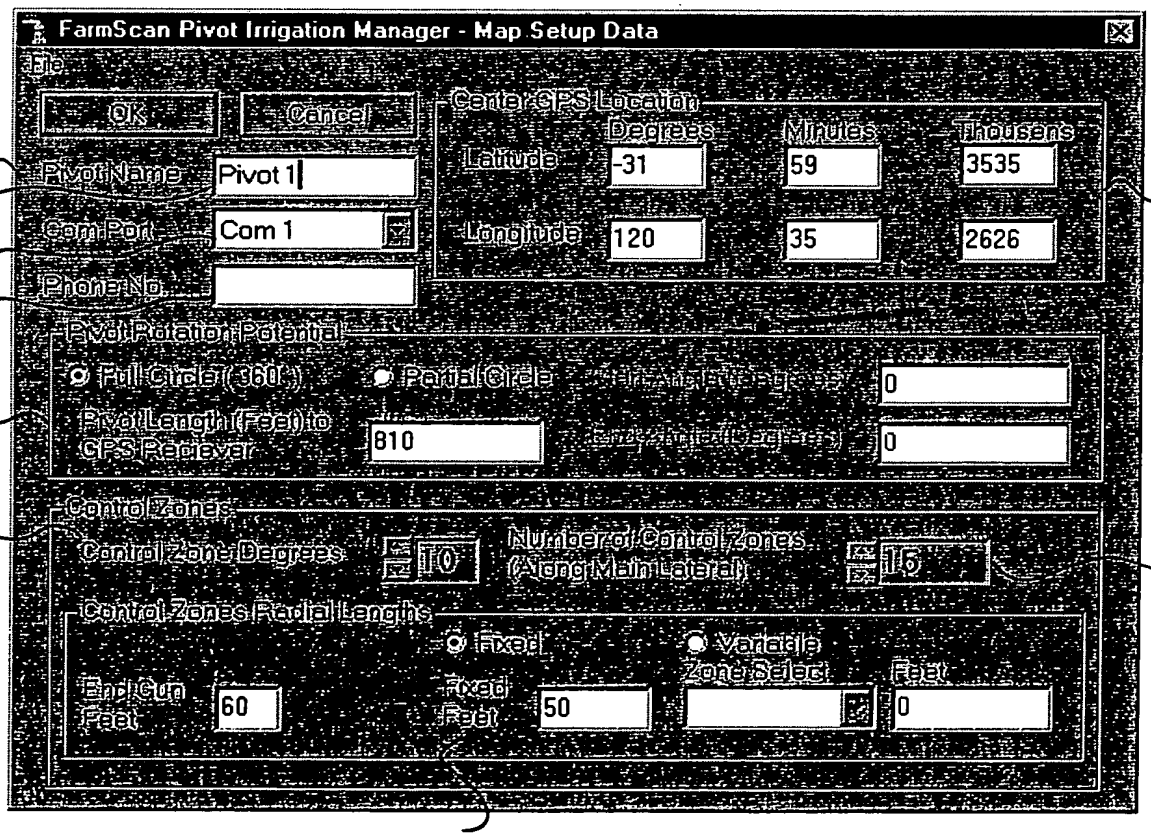

Figure 2

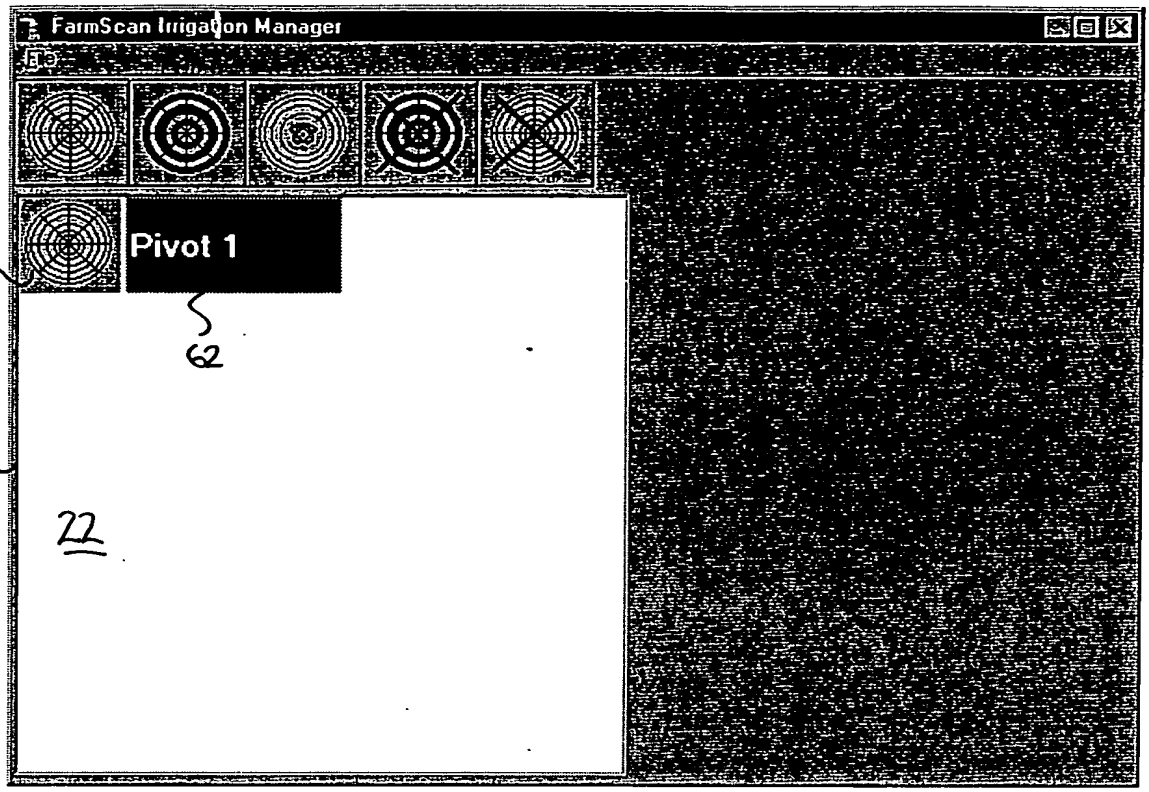

Figure 3

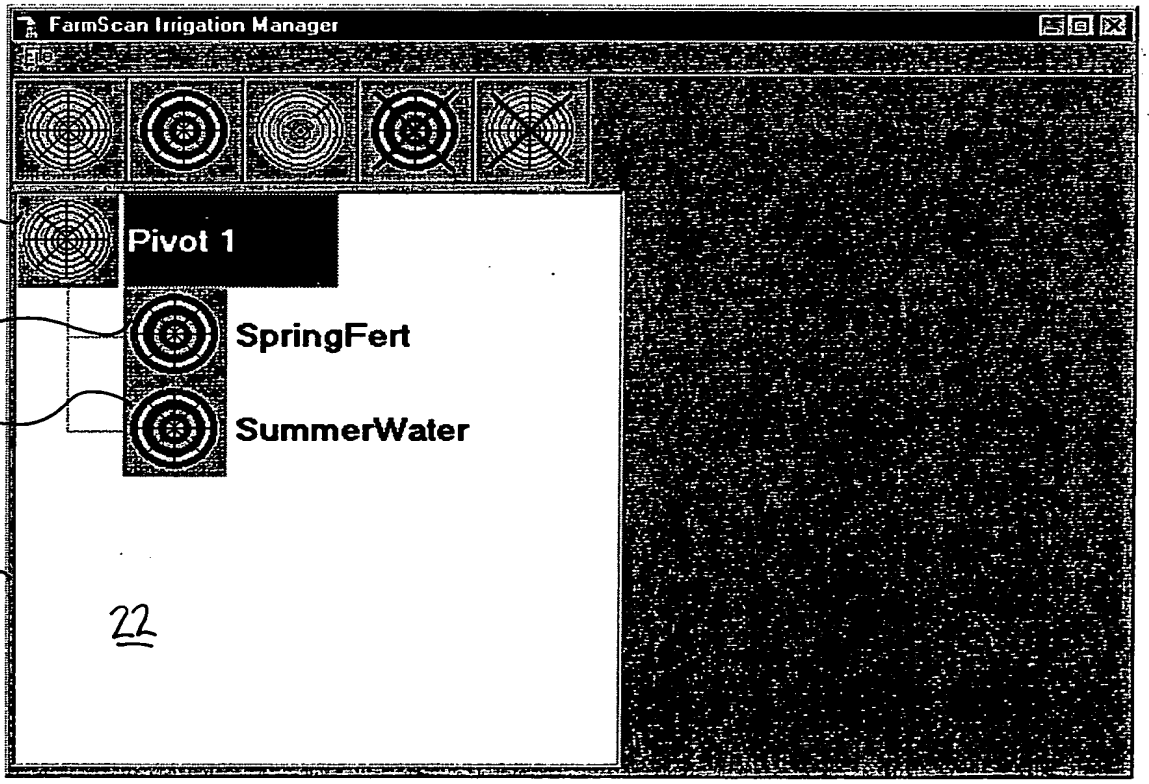

Figure 4

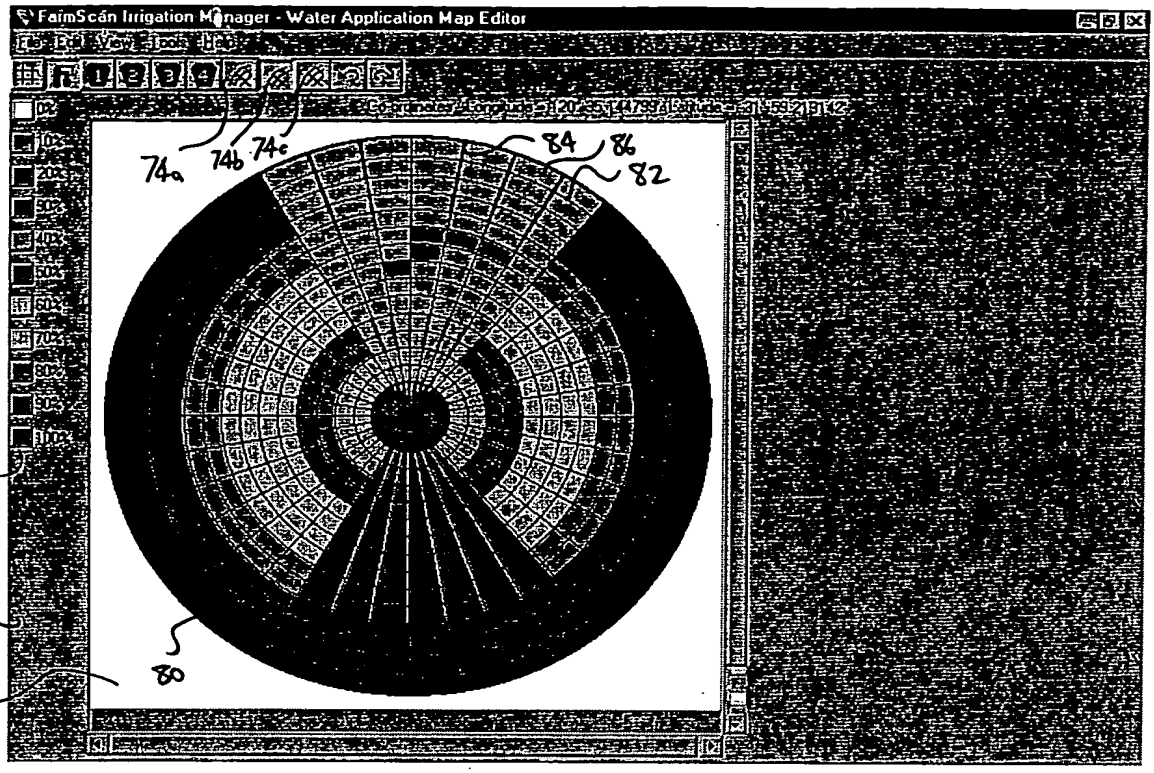

Figure 5

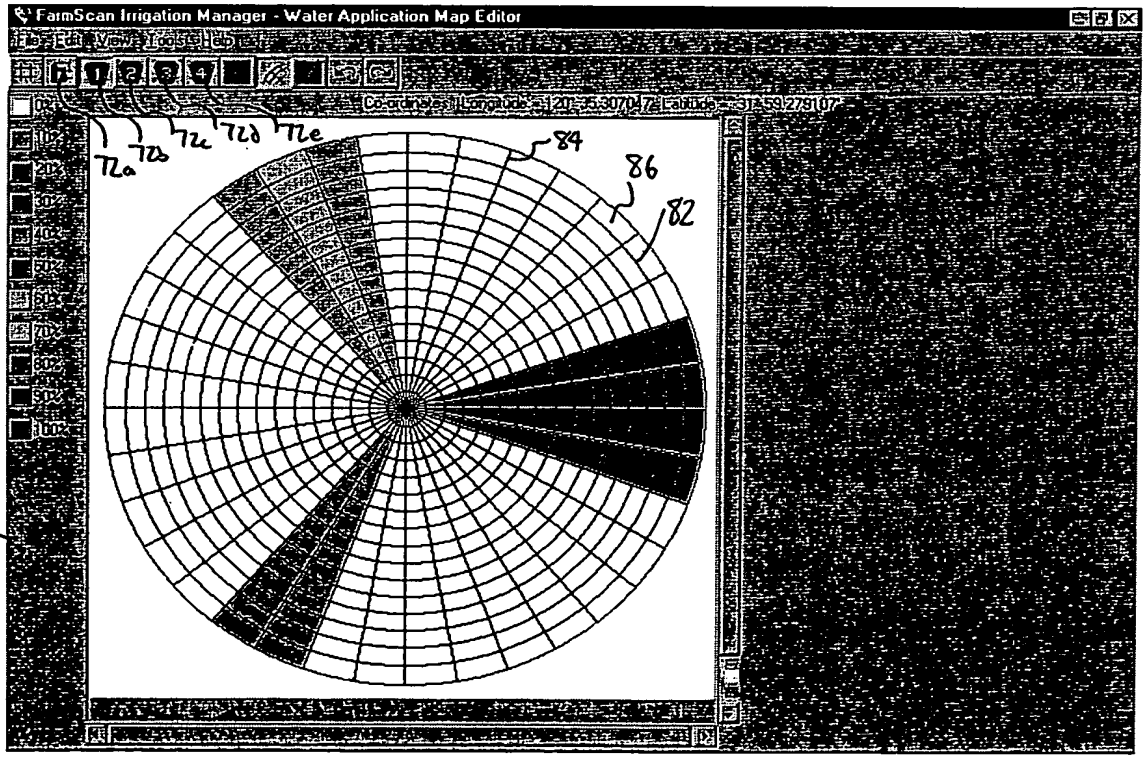

Figure 6

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